International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 05-07-2025, Accepted: 05-08-2025, Published: 20-08-2025
Volume 7, Issue 4, 2025, Page No. 105-108

Management of anthracnose disease of chilli

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Abstract
Chilli crop suffers from various diseases in which anthracnose caused by *Colletotrichum capsici* is a very serious one, causes huge yield losses in India. The present investigation was carried out to find out its suitable control measures by evaluating different fungicides including bio-agent. Seven treatments were taken *in vivo* at Regional Research Technology Transfer Station(RRTTS) G.Udayagiri, Kandhamal district of Odisha, India to find out suitable control measure of anthracnose disease of chilli.Treatments were T1-3Spraying of Propiconazole 25 EC @ 1ml/l ,T2- 3Spraying Tebuconazole (25EC)@ 1ml/l .T3- - 3Spraying of Difenconazole 25EC @ 0.6ml/l T4- 3 spraying of Azoxystrobin 23SC@1ml/l T5 - 3spraying of Azoxystrobin(12.5%)+ Tebuconazole (12.5%) @ 1ml/l , T6-seed treatment wit *T . viride* @5gm/kg of seed + soil application of 4kg of bio-agent in 10q of FYM incubated for 15days under shed and applied during earthing up, T7-control (no spraying). 3sprays (1st before flowering, 2nd at fruit formation and 3rd fortnight interval after 2nd spraying). It is observed that 3Spraying of Azoxystrobin (12.5%) +Tebuconazole (12.5%) 1ml/l before flowering, at fruit formation and 15days after 2nd spraying can able to manage the disease upto 44% over control followed by 3spyaying of Difenconazole 25EC @0.6ml/l to manage disease up to 35%.

Keywords: Chilli, anthracnose and fungicide

Introduction

In India, total area under chilli cultivation is 377 thousand ha with production of 3783 thousand MT during 2019-20 (Anonymous 2019-20) [3]. The major chilli growing states are Andhra Pradesh, Karnataka, Maharashtra, Orissa, Tamil Nadu, Madhya Pradesh, West Bengal and Rajasthan that account for more than 80% of the total area and production. *Capsicum annuum* is a good source of Vitamin A and C, potassium, and folic acid. Fresh green chilli has more vitamin C than a citrus fruit, whereas red chilli has more vitamin A than in carrots. Besides its wide use as vegetable, spice, and condiments, it is also used in medicines and beverages. Capsaicinoid and caretenoids are the active ingredients of the chilli; the capsaicinoids are nonvolatile alkaloids that make chilli pungent, and caretenoids have nutritional value that also provides color to the chilli fruit. Most of the fungicides have fungistatic and fungicidal activities. Hence, it is essential to recommend the appropriate fungicide and its concentration to reduce the yield loss caused by them. There are two important commercial qualities that makes Indian chilli world famous are color and pungency levels. chilli can reduce the risk of cancer by preventing carcinogens from binding to DNA and reduce calorie intake by increasing the remoteness on perceived scientific and economic. Due to its wide spread usage, chillies are a highly significant vegetable found to have many medicinal properties Chilli crop is attacked with different pests and pathogens in field and during post-harvest, contamination with mycotoxins are major constraints in chilli production. Worldwide, Capsicum is vulnerable to various pests, weeds, fungal, bacterial, and viral pathogens. Anthracnose symptoms on chilli appeared in the form of small circular spots appear on the leaves. On fruit typical symptoms were found as circular or angular sunken lesions with a slightly raised rim. Plant diseaseknown as anthracnose is characterized by very dark, sunken lesions that contain spores (Isaac, 1992) [13]. As they enlarge, they become irregular in shape, variable in size and give a scorched appearance. According to Pakdeevaraporn *et al*. (2005) [24], up to 50% yield losses may occur due to small-circular lesions that form on mature fruits. Severely infected leaves and fruits fall off leading to defoliation. In general, the disease outbreak occurs during the rainy season or a long rainy period and it has reduced chilii yields. In addition, farmers primarily apply synthetic fungicides as curative and preventative measures against chilii anthracnose. Despite the effectiveness of synthetic fungicides against the anthracnose pathogen, their repeated and ongoing use raises concerns not only for their impact on human health, consumers and the environment, but also for the pathogen resistance that may result (Saxena *et al*., 2016; Hawkins and Fraaije, 2018 [10]; Kongcharoen *et al*., 2020) [16, 27].Consequently, the use of biological control agents (BCAs) and plant extracts is safe and eco-friendly methods of controlling plant pathogens have replaced the use of systemic fungicides (Jantasorn *et al*., 2016; Komhorm *et al*., 2021) [14, 17]. In addition, Numerous studies have revealed that *Colletotrichum* infects a variety of tropical, subtropical, and temperate fruits, crops, and ornamental plants with anthracnose disease and postharvest decay (Lima *et al*., 2011 [19]; Damm et al. 2012 [6].

As the pathogen is seed-borne, there is threat of introduction of this pathogen along with import of germplasm (including Chilli) from different countries; therefore, while importing from any other country, there is a need to examine the samples very critically including sensitive molecular diagnostic tools to prevent entry of this pathogen associated with germplasm.

Materials and Methods

One experiment was conducted at Regional Research Technology Transfer Station(RRTTS) G.Udayagiri, Kandhamal district of Odisha , India to find out suitable control measure of anthracnose disease of chilli.Treatments

were T1-3Spraying of Propiconazole 25 EC @ 1ml/l ,T2-3Spraying Tebuconazole (25EC)@ 1ml/l .T3- -3Spraying of Difenconazole 25EC @ 0.6ml/l T4- 3 spraying of Azoxystrobin 23SC@1ml/l T5 - 3spraying of Azoxystrobin(12.5%)+ Tebuconazole (12.5%) @ 1ml/l , T6-seed treatment wit *T . viride* @5gm/kg of seed + soil application of 4kg of bio-agent in 10q of FYM incubated for 15days under shed and applied during earthing up, T7-control (no spraying). 3sprays (1st before flowering, 2nd at fruit formation and 3rd fortnight interval after 2nd spraying). Design-RBD, Season -Kharif 2023 and 2024.

The field was ploughed two times and planking was done after each ploughing, seeds were sown in line with spacing 60 x 30 cm and seed rate was 500 g per ha. soil test-based fertilizer application was done. seed treatments, soil drenching and spraying were done as per the treatments. The farmers practices were maintained in case of local checks. The observations were recorded on pod yield, per cent disease control and B:C ratio.

The Percentage disease in tensity (PDI) was calculated according to the formula proposed by Mayee & Datar (1986) [20] given below; PDI = [(sum of scores of infected leaves per plant)/ (total number of leaves observed × maximum disease score)] × 100 (Palarpawar & Ghurde 1989) [7].

Standard Disease Rating Scale (0-9 Scale) For Assessing Pdi of Anthracnose of Chilli

1-No symptoms on plant: 1- Small spots on leaves, less than 1 per cent of leaf area diseased; 3-Medium six spots on leaves covering 1-10 per cent infected area; 5- Spots big; coalescing

2-covering 11-25 per cent of leaf area: 7- Spots large; coalescing covering 26-50 per cent of leaf area; 9- Spots on leaves covering above 51 per cent of leaf area.

Result and Discussion

Results (Table 1) revealed that all the treatment sprays significantly reduced the percentage anthracnose disease incidence of chilli. The disease was found to appear about 36 days after transplanting of the crop and its incidence at first appearance was ranged from 20 to 30 per cent, which increased steadily upto second spray treatment and subsequently decreased thereafter second spray treatment. . Efficacy of fungicide for management of chilli anthracnose Disease control was recorded with the fungicides of 3spraying of Azoxystrobin (12.5%) + Tebuconazole (12.5%) @ 1ml/l (43%) followed by Difenconazole 25EC @ 0.6ml/l (35%) over untreated control and all the treatments were found significantly superior over unsprayed control with maximum yield of red chilli and highest cost: benefit ratio. However, Seed treatment with T. viride25g/kg of seed +soil application of 4kg Bio-agent incubated in 10q of FYM under shed for 15dys and applied during ear thing up could able to manage the disease up to24% only. Tanwar & Bunker (2013) [28] conducted studies for the control of anthracnose and reported that two fungicides namely Tebuconazole and Propiconazole significantly reduced anthracnose in chilli. Goswami et al. (2013) [9] reported that sprays with chemical fungicides including Mancozeb 75WP @0.3% effectively control chilli anthracnose. Akhtar 2007 [1] reported that different strategies for managing the disease are recommended and chemical control is found most effective and practical method. As time required for controlling the disease with chemical method is much lesser as compared to the time required for the development of resistant cultivar. Use of protective fungicide like manganese ethylene bisdithiocarbamate (Maneb) is widely recommended for managing this disease. Other dithiocarbamate fungicides like Mancozeb (0.2%), ziram (0.1%), copper oxychloride fungicide (Blitox 50), and Bordeaux mixture (0.5 or 1%) of a copper sulphate fungicide were found effective in managing this disease. Seed dressing with benzimidazole fungicides (Benlate, delsene M) and strobilurin fungicide (azoxystrobin) are recommended [Yu *et al.* 2009] [31]

Gopinath *et al.2006* [8] and Boonyapipat 2012 [4] suggested that other systemic fungicides from triazole group propiconazole , difenoconazole, benzimidazole fungicide have been used in both pre and post-harvest management of chilli anthracnose, as propiconazole, exhibited the highest level of inhibition of *in vitro* mycelial growth, biomass production, sporulation and spore germination at concentrations as low as 0.1 mg/ml. Than *et al.*2008 [29] and Anand *et al.* 2010 [2] reported that different strobilurin fungicides azoxystrobin (Quadris), trifloxystrobin (Flint) and pyraclostrobin (Cabrio) have also been recommended for effective management of the disease .Ramdial *et al.* [25] ,Inada *et al.* [12] and Hu *et al.* [11] reported that strobilurin-fungicides (azoxystrobin and kresoxim-methyl control anthracnose disease of chilli.

Anand *et al* .2010 [2] reported that combined application of Bioagents with chemicals are recommended, *Pseudomonas fluorescens* along with half of the recommended dose of azoxystrobin fungicide has been found effective and viable option to control fruit rot. Voorips *et al*. 2004 reported that use of chemicals is not eco-friendly and it leaves chemical residue in chilli fruits, which hinders the export, and there are numerous reports describing negative effects of using chemicals on farmer's health in developing countries. To overcome the undesirable effects of chemical usage alternate methods such as use of bioagents, plant extracts or use of chemicals in combination with these are recommended to control the infection.

Boonratkwang *et al.* and *S*ingh et al. *2007* [5] reported that*Trichoderma* species is the fungal antagonist which is widely applied to control *Colletotrichum* species in chilli. Kasyap *et al.* 2017, Maymon *et al.* 2004 [21] and Jeffries *et al.* 1992 [15] suggested that *Trichoderma* species are able to effectively compete for surface area, thereby reducing pathogen infection success. Ngullie *et al.* 2010 [22] reported that in vitro studies indicated that *T. viride* and *P. fluorescens* are very effective in inhibiting mycelial growth of the pathogen. Ready *et al*.2019 suggested that suggested that the use of *T. viride* and *P. fluorescens* individually or in combination known to significantly lower the anthracnose disease incidence and should be used as an alternative to chemical control.

Management of Anthracnose disease of chilli (*C. capscici)*				
Treatments	Percentage disease incidence after 3 spraying	Percent disease control	Yield (q/ha)	B:C ratio
T1-3Spraying of Propiconazole25EC @1ml/l	25.05 (14.49)	32.07	72.00	2.4

T2-3Spraying of Tebuconanazole25EC @1ml/l	25.28 (14.64)	31.39 (18.29)	68.60	2.28
T3-3Spraying of Difenconanazole25EC @1ml/l	23.77 (13.75)	35.49 (25.79)	69.50	2.31
T4-3Spraying of Azoxystrobin 23SC @1ml/l	27.43 (15.91)	25.56 (14.80)	62.30	1.93
T5-3Spraying of Azoxystrobin (12.5%) +Tebuconanazole (12.5%) @1ml/l	20.71 (12.00)	43.79 (25.95)	80.40	2.68
T6-Seed treatment with T. viride25g/kg of seed +soil application of 4kg Bio-agent incubated in 10q of FYM under shed for 15dys and applied during ear thing up	27.89 (16.20)	24.31 (14.06)	65.20	2.23
T7-control (No spyaing)	36.85 (21.62)		55.60	1.85
SEM (+-)	1.45			
C.D. (0.05)	4.34			
NB: 3spraying (1st before flowering,2nd at fruit formation, 3rd fortnight after flowering) Figures in parentheses are in angular transformed values				

Conclusion

3Spraying of Azoxystrobin (12.5%) +Tebuconazole (12.5%) 1ml/l before flowering, at fruit formation and 15days after 2nd spraying can able to manage the disease upto 44% over control followed by 3spyaying of Difenconazole 25EC @0.6ml/l to manage disease up to 35

Future studies

Multilocational trial of this trial will be taken in all 10 agroclimatic zones of Odisha.

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